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2004 EPA STAR Graduate Fellowship Conference *Next Generation Scientists—Next Opportunities*

Water flow reduces bleaching and thermal stress on photosystem function in the coral *Porites divaricata*

Porites divaricata on Old Sweat Bank, Florida Bay

Bleached *Porites divaricata*

Abstract

Coral reefs are exceptionally important ecosystems socioeconomically and ecologically. Much of the world's population is distributed along tropical coastlines and millions of people depend on healthy coral reef ecosystems for a variety of needs. Coral bleaching is a severe global threat that is expected to increase in frequency and intensity over the next several decades as a result of climate change, yet not much is known about how to reduce bleaching. The branching coral *Porites divaricata* is often found in very shallow areas with high solar irradiance, temperature, and water velocity. High temperature and solar irradiance contribute to coral bleaching and there is evidence that water motion may alleviate these affects. The hypothesis that increased water motion reduces bleaching (loss of zooxanthellae cells from the coral) and bleaching stress in *P. divaricata* was tested using paired flume experiments with different water velocities under conditions of high temperature and high solar irradiance. One measure of bleaching stress, decrease in photochemical efficiency of Photosystem II (F_v/F_m), is greater in "slow flow" (2-3 cm s^{-1}) compared to "fast flow" (14-21 cm s^{-1}) after one day of exposure to bleaching conditions. Photochemical efficiency was also significantly affected by water temperature. Bleaching was significantly greater in corals in the slow flow treatment. **These results support the hypothesis that increased water motion alleviates bleaching and the effects of thermal bleaching stress on photosystem function in the coral *Porites divaricata*.**

Environmental Issue

In this research I examine factors that influence coral bleaching and how bleaching might be alleviated.

Introduction

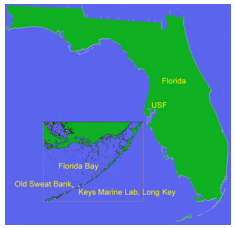
- There is evidence of a negative relationship between water motion and the severity of bleaching.
- If bleaching is affected by water motion, it may be due to enhanced transport of dissolved chemicals into or out of coral tissue.
  - Reactive oxygen species – cause cell damage
  - Nutrients – affect cell stress level

Hypothesis

Water flow reduces bleaching in *Porites divaricata*

Methods

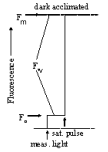
- *Porites divaricata* were collected from Old Sweat Bank in the Florida Bay.
- Experiments were conducted at Keys Marine Lab, Long Key, Florida.



Paired flume experiments

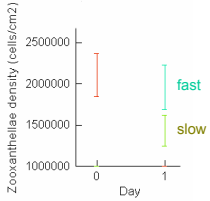
- Bleaching conditions: full sunlight, high temperature
- All conditions identical except velocity
- 2–3 cm s^{-1} (slow flow) vs. 14–21 cm s^{-1} (fast flow)
- Six corals per experiment, ten experiments

- Bleaching was measured as decrease in zooxanthellae density (cells cm^{-2}).
- Thermal stress on photosystem function was measured as decrease in photochemical efficiency (F_v/F_m) using a **pulse-amplitude modulated (PAM) fluorometer**.
  - F_o – Initial dark-acclimated fluorescence
  - F_m – Maximum dark-acclimated fluorescence
  - F_v/F_m – Photochemical efficiency (which is known to decrease in bleached corals)



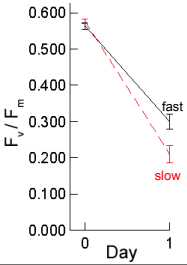
Results

Bleaching is reduced in fast flow



Mean zooxanthellae density decreased in 2-3 cm s^{-1} flow ($p = 0.02$, $N = 15$), but did not decrease in 14-21 cm s-1 flow ($p = 0.43$, $N = 15$).

Thermal stress on photosystem function is reduced in fast flow



F_v/F_m decreased during one day exposure to bleaching conditions ($P < 0.001$, $n = 60$)

F_v/F_m decreased more in slow flow than fast flow ($P < 0.001$, $n = 60$)

Impact

This research demonstrates that water flow reduces bleaching stress in corals, aiding managers in identification of habitats most critical for conservation.

Acknowledgements

Thanks to my advisor, Flo Thomas; members of my committee, John Ogden, Pam Hallock-Muller, and KT Scott; Thanks also to Mary Alice Coffroth, Gary Huxel, Bill Fitt, Ray Martinez, Pete Bowma, Annisa Karim, Traci Van Deusen, Madelyn Joy, and staff of Keys Marine Lab. Collection of coral was permitted under Florida Keys National Marine Sanctuary Permit 2003-009. This research was aided by an EPA-STAR Fellowship, Grant In Aid of Research from Sigma Xi, the Scientific Research Society, and National Science Foundation grant OCE-9996361 to F. Thomas. This research was presented at the 10th International Coral Reef Symposium (Okinawa, 2004) and will be published in the ICRS Proceedings. For more info, email Seán Kinane: skinane@mail.usf.edu

This fellow is sponsored by EPA's STAR or Greater Research Opportunities (GRO) Program.